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Establishing a Brain Styles Test: The YBRAINS Test

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Abstract

Teaching with knowledge of students' thinking and learning styles increases its effectiveness. The YBRAINS test is developed to help school teachers to understand the thinking and learning readiness levels of their students in the process of providing effective teaching and learning activities. The test was established based on theories and brain experiment research evidences. This article reports the rationale of establishing the test and its validity and reliability.

Keywords: Brain style, thinking and learning, YBRAINS, validity and reliability

1. Background

One of the major goals of the Malaysian National Mission in producing first class human resources, as has been documented in the Malaysian Education Master Plan 2006-2010, is to produce "first class minded" students. Specifically, it aims to equip students with science, technology, innovative, creative and all-round soft and hard skills (core element 2, Ministry of Education Malaysia, 2007, pp13). As a consequence, educational transformation has been initiated, and teaching and learning strategies that focus on enhancing the "human mind", emphasis on all-round skills in enhancing critical thinking left brain the and creative thinking right brain across school subjects have been introduced at all levels in schools (Suresh, 2009). However, it was observed that the teaching and learning strategies are implemented in schools without considering students' thinking and learning styles.

Teaching with knowledge of students' thinking and learning styles increases its effectiveness. It's difficult for a school teacher to provide teaching activities and materials that best accommodate students' thinking and learning styles without knowing students' thinking and learning styles (Chua, 2009). According to some scholars, matching teaching styles to thinking and learning styles will increase academic achievement and make the teaching and learning process an enjoyable experience (Naimie, Siraj, Chua, Shaghoi & Ahmad Abuzaid, 2010; Chua, 2010). Therefore, an attempt has been initiated to build a test of thinking and learning style. It was developed to help school teachers to understand their students' thinking and learning styles. The instrument named YBRAINS, consists of 25 items, was developed based on theories and evidences of brain researches.

2. Theories and evidences of brain styles

People naturally learn and think in different ways. Split brain experiments' evidences have indicated that both human brain, i.e. the left and the right brain think and learn, or process information differently. Several scholars (Springer and Deutsch, 1993; Torrance, 1982; Bogen, 1975) suggested that when people are thinking or learning, they tend to rely on either the left or the right brain. The tendency for a person to rely either the left or the right

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brain in processing information is called brain hemisphericity (Torrance, 1988). Based on experiences and research findings, educational psychologists (Osborn, 1963; Ornstein, 1977; Bamber, 1983 and Ibrahim, 1998) argued that an educational practice is one of the factors of brain hemisphericity.

For ages, many educational psychologists have recognised the distinctly different roles of both hemispheres of the human brain. Traditionally, the left hemisphere has been referred to as the dominant hemisphere, which has more functions in thinking and learning process, and the right hemisphere as the minor hemisphere. However, it is now believed that both of the hemispheres are important in thinking and learning processes.

Bogen (1975) was the first person who uses the word "brain hemisphericity" or "brain thinking and learning style". In his "parallel ways of knowing model", Bogen believed that there are two distinct ways of knowing, which are opposite one and the other. The first way of knowing is related to intuition, divergent, imaginative, holistic and subjective ways of thinking (right brain functions). In contrast, the second way of knowing is related to Intellect, logical, convergent, rational, sequential, analytic and objective ways of thinking (left brain functions). Another scholar, Munzert (1991) in his effort to develop an IQ test asserted that the differences between left and right hemispheres' functions are qualified by the mental activities, which are processed in each half of the brain. His theory of "Intelligent creativity-creative intelligent" asserted that the left brain is the "intelligence creativity" side, and it is the control centre for such intellectual functions, such as time, memory, numbers, language, speech, logic, analysis, sequence, classification, computation, and seriation. These functions encompass the abilities necessary for academic success. While the right brain is the "creative intelligence" side, and it is the control centre for the mental functions involved space, intuition, attitudes, emotions, extrasensory, rhythm, music, dance, synthesis, fine arts, mechanics, physical coordination, and visual-spatial.

Similarly, Torrance, Reynolds, Riegel and Ball (1977), in their efforts to establish a brain style test (i.e. the Your Style of Learning and Thinking Test) listed the functions of the left and right brain. The functions of the left brain included recognising and remembering names, responding to verbal instructions, systematic and controlled in experimenting, dependent upon words for meaning, produced logical ideas, processes verbal stimuli, objective processing of information, serious, systematic in solving problems, receptive, abstract thinking, dislike improving, not psychic, little use of metaphor and analogies, responsive to logical, verbal appeals, deal with one problem at a time, sequentially, critical and analytical in reading, logical in solving problems, gives instructions verbally, uses language in remembering, and grasps certain and established truth. On the other hand, The functions of the right brain included recognising and remembering faces, responding to visual and kinaesthetic instructions, playful and loose in experimenting, responds with emotion and feeling, interprets body language, produces humorous ideas, process kinaesthetic stimuli, subjective processing of information, playful in solving problems, self acting; concrete thinking, likes improving; highly psychic, high use of metaphor and analogies, responsive to emotional appeals, deal simultaneously with several problem at same time, creative, synthesising, associating in reading, intuitive in solving problems, gives instructions through movement and gesture, uses images in remembering, and grasps uncertain truth.

Empirical evidences of the functions of the left and right hemispheres were basically based on the observation on brain damage patients and split brain experiment studies (Gazzaniga, 2002; Springer and Deutsch, 2001; and Sperry, 1975). According to the split brain theory, derived from findings of the split brain experiments, the left brain involves with verbal, logical, sequentially-order, rational, realistic, evaluation, critical reasoning, and convergent tasks, while the right brain processes visual, non-verbal, intuition, non-linear, spatial, artistic, musical, holistic, imaginative and creative information (Szirony, Burgin, & Pearson, 2008; Weinberger, 2004; McManus, 2002; Saleh and Iran-Nejab, 1995; Shiflett, 1989; Ibrahim and Davis, 1989; Carol, 1989; Yarlott, 1986; Dombrower, Favero, King, Dombrower & Michael, 1982; Torrance, 1982; Herrmann, 1981; Sperry, 1975).

3. Indicators of brain styles

Besides referring the above mentioned theory and models, the items of the YBRAINS test were developed based on research evidences of split brain experiments including the blood flow technique (Lassen, 1972), dichotic listening technique (Bethmann, Tempelmann, De Bleser, Scheich & Brechmann, 2005; Kimura, 1961), electroencephalogram or electrical brain writing technique (Galin and Ornstein, 1972), and hemispheric functions on visual stimuli study (Levy & Trevarthen, 1976). In additions, findings of the left brain and right brain functions

derived from psychological tests such as the literal preference test (Porch and Coren, 1981) and the street gestalt completion test (Bogen, 1975) were also be referred.

3.1. Left brain style

The indicators of left brain thinking and learning style included: Good in logical, rational and analytical thinking, evaluate materials in rational way, works in a systematic manner, follows rules, processes information sequentially, or step by step, inhibited in responding emotionally, prefer structured activities, proficient in language and verbal activities, prefer science and mathematics subjects, suitable for works which need the skills of systematic, logical thinking and decision making, prefer words over picture or images when reading, prefer using right side of the body for physical activities (the left brain controls right side of the body), emotion is hardly influent by the people, dislike nonsense and less logic idea, prefer learning language subjects, like to tell real stories, realistic in thinking, like to work in a serious, structured, and office-like environment, like routine and repetitious works, tend to match visual stimuli with its function (derived from the laterality study for hemispheric functions on visual stimuli), and less ability in right brain functions.

3.2. Right brain style

The indicators of right brain thinking and learning style include: Creative, imaginative in thinking, like to produce original ideas, good in spatial relationship, has a highly adventurous and inventive mind, solves problem intuitively, act spontaneously, response with emotion and feeling, prefers open-ended assignment, has a good sense of humour, has an open mind in everyday life, prefer using left side of the body in physical activities like to response to music and art, or innate musical and artistic talent, suitable for works that need the skills of spatial relationships, understand creative expressions in paintings (the aesthetics values of impressionism, surrealism and cubism art works, such as the aesthetics values in Vincent van Gogh, Claude Monet and Pablo Picasso' paintings), emotion influent by others, good at recall image, like to tell humorous jokes, like to work in a playful environment, inventive in thinking, like non-structured works, tend to match visual stimuli with its appearance, and less ability in left brain functions.

3.3. Whole brain style

The indicators of whole brain thinking and learning style include: Has a balanced thinking style, i.e. presents a mixed style of abilities and characteristics of the left brain and right brain styles, works better with task that needs the skills of both the right and left brain. Besides the three brain styles, the test is also measuring the level of openness in thinking. Openness is viewed as associated with the right brain functions, such as appreciation for art, emotion, adventure, unusual ideas and imagination (Runco & Pritzker, 1999). In the test, the openness levels (open style, mixed style and closed style) are identified based on the following openness indicators: generous in sharing idea with others; like to communicate ideas freely; have positive emotion; extraversion; practicing active listening, and listening with understanding; open to what others are saying; not being unreceptive to other ideas and opinions; and receptive to new experience and changes. It is important for an instructor to identify the openness level of a learner before preparing a lesson because teaching is less effective if the student's mind is closed for learning.

4. Establishing the YBRAINS test

Treffinger (1986) pointed out that there is no single, uniformly accepted theory of thinking, and there is also no single assessment instrument of thinking that is and will be universally accepted. Pertaining to brain style, Torrance (1988) stated that if information about the specialized functioning of the two cerebral hemispheres is to become useful to educators, educational psychologists must invent a variety of instruments and recalibrate many existing instruments, while Starko (2004) asserted that the use of a typical thinking instrument is depended on the need and the purpose of its developer, and varying theories and definitions will support differing types of assessment.

According to some well-known educational test developers (Torrance, 1984; Watson-Glaser, 1980; Taylor and Getzels, 1975), the general criteria for selecting specific thinking test are: (1) It must have relevance to thinking theory, (2) It must have relevance to thinking behaviour in the real world, (3) it must simply a different aspect of thinking behaviour, (4) it must be attractive to the respondent, (5) it must be built so that a person can respond in terms of his/her experiences whatever these may have been, (6) it must yield data that can be scored reliably for meaningful aspects of thinking, and finally, (7) the testing materials, instructions for administration, time limits, and scoring procedures must be clearly and relevantly stated.

The items of the YBRAINS test were developed based the general criteria suggested by the test developers mentioned above. Besides that, the items were also built on the rationale that thinking and learning styles can be identified, quantified, and represented by scores (Starko, 2004).

The YBRAINS test consists of 25 items. The items are used to collect data concerning brain styles (left brain, right brain of whole brain style) and openness level (open style, mixed style or closed style) of a respondent. Each item provides respondent with multiple choices – each choice representing a specialised function of the left brain, or a parallel function of the right brain. The respondent is asked to indicate which of the specific brain functions best describes his/her own typical behaviours (not the statement that is correct to most people). The responses are then calculated to obtain a brain style score (divide the total point scored by the number of responses made by the respondent). The brain style score is then categorised into three thinking and learning styles based on a 9-point index which was divided into three sections: *left brain style* (section 1): 1.0 – 4.5 points; *whole brain style* (section 2): 4.6 - 5.4 points; and *right brain style* (section 3): 5.5 –9.0 points. For the openness level, the scoring is similar to provide a three sections' openness styles: *open thinking style* (section 1): 1.0 – 4.5 points; *mixed thinking style* (section 2): 4.6 - 5.4 points; and *closed thinking style* (section 3): 5.5 –9.0 points (Figure 1). The whole brain and mixed thinking are set at a narrow range of 4.6 - 5.4 point (a 10% of the 9-point scale) because for a person to be balanced in brain style, the maximum range of difference between the scores of the two hemispheres is 10%.

The three brain styles and thinking styles is then arranged in a two-dimensional matrix, to create a typology diagram (Figure 1). The typology diagram presents a new model: the Brain Style Model.

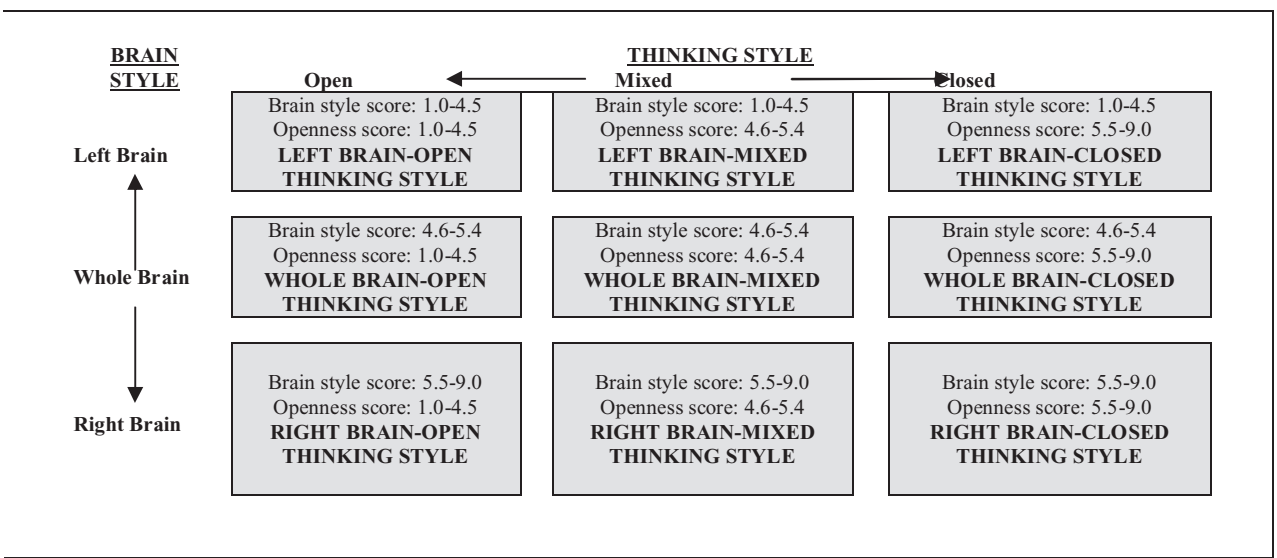

Figure 1: Typology diagram of the brain style model generated from the YBRAINS test

The YBRAINS test is developed in a computer-based system by using a visual basics programme. When a respondent responds to the test items, his learning and thinking styles (left, right or whole brain style, and open, mixed or closed thinking style), as well as the strengths, weaknesses and some suggestion to his style will be presented instantly by the computer programme. Besides that, the test uses a nature friendly background to stimulate

respondent's thinking when he responds to the test items. Figure 2 indicates an example item and the results of the test in graphical form (*The test has won two gold medals in innovation expo, including the 21st International invention, innovation & Technology Exhibition, 2010*).

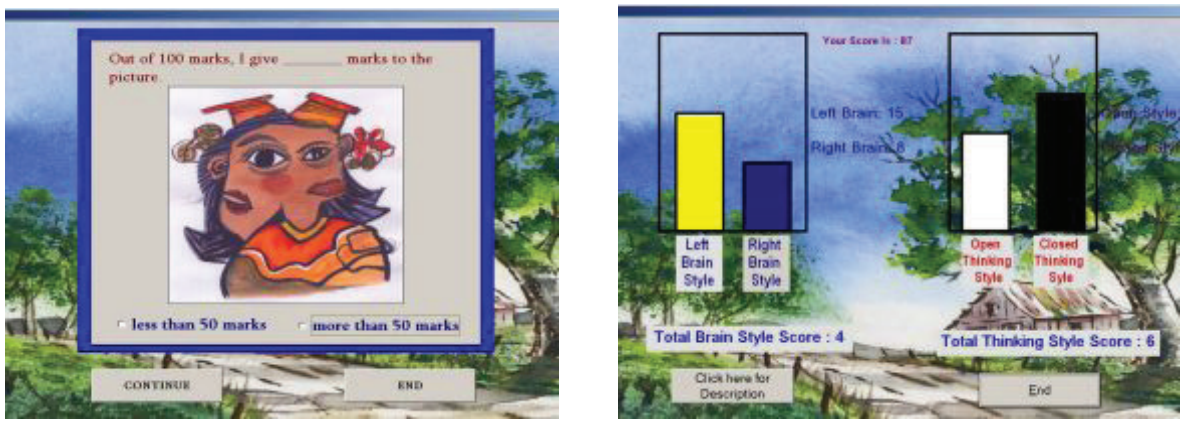

Figure 2: An example of test items and the results of the test in graphical form

5. Reliability and validity of the YBRAINS test

The items of the YBRAINS test were established on the assumptions that thinking and learning styles can be identified, quantified, and represented by scores. In order for these assumptions to be met, instrument used for measurement must meet the test of validity and reliability (Starko, 2004).

5.1. Reliability

Test-retest reliability of the YBRAINS was conducted in two studies. The first study tested 224 student teachers (103 males, 121 females; average age: 19.1 years old) of a undergraduate teacher training programme at the Kuala Lumpur Specialist Teacher Training Institute, and retested the same students three months later. The Pearson product-moment correlation coefficients were positively significant for both of the thinking and learning styles (left brain style: $r = .87$, $p < .05$; right brain style: $r = .84$, $p < .05$). The second test was conducted on 127 sixth-form students (54 males, 73 females; average age: 18.0 years old) of the Seri Serdang Secondary School in a range of five months in 2008. The product-moment correlation coefficients were also positively significant for both of the thinking and learning styles (left brain style: $r = .89$, $p < .05$; right brain style: $r = .82$, $p < .05$). Ling (2010) in a study (on a group of 85 secondary school principals: 45 males and 40 females; average age: 45.1 years old) reported that the internal consistency reliabilities (Cronbach's alpha values) of the left, right, open and closed style are .74, .72, .76, and .84.

5.2. Validity

The validity of the YBRAINS test will be presented in terms of content, concurrent, construct and predictive validity.

5.2.1. Content validity

The items of the YBRAINS test were constructed by attempting to transform theories and research findings regarding the functions of the left brain and right brain into a multiple-choice test format, with each choice representing either a left brain style or a right brain style, and either an open or closed thinking style.

5.2.2. Concurrent validity

Concurrent validity examines whether an instrument correlates with current measures. The concurrent validity study for the YBRAINS test was conducted on a group of 223 students (102 males, 121 females; average age: 19.1 years old) undergraduate student teachers from the Kuala Lumpur Specialist Teacher Training Institute. The study identified correlation between the YBRAINS test and two thinking and learning styles instruments. The two instruments are: (1) The Styles of Learning and Thinking Test or SOLAT (Torrance, 1988). The SOLAT test (youth form) consists of 28 items. Each item of the test provides two choices – one representing a specialised function of the left brain, and the other representing a specialised function of the right brain. A respondent is asked to indicate which of the two specific learning and thinking styles best describes his own typical behaviour. (2) The Brain Works (Synergistic Learning Incorporated, 2006) test. The Brain Works test is a 20 items, triple-choice, computer operated self-assessment instrument. The three choices of each item represented the left brain, the right brain, and the mixed brain dominant thinking and learning styles.

The results of the two concurrent validity studies are presented in Table 1. As shown in Table 1, the scores of left brain style of the YBRAINS were positively and significantly correlate with the left brain style of the SOLAT ($r = .75$, $p < .01$) and the Brain Works ($r = .66$, $p < .05$). On the other hand, the scores of right brain style of the YBRAINS were positively and significantly correlated with the right brain style of the SOLAT ($r = .73$, $p < .01$) and the Brain Works ($r = .56$, $p < .05$).

Table 1. Correlation between the scores of the YBRAINS with the scores of the SOLAT and the Brain Works

Correlation	Left Brain Style	Right Brain Style
Styles of Thinking and Learning (SOLAT) - YBRAINS	.75**	.73**
Brain Works - YBRAINS	.66*	. 56*

Note: *significant at $p < .05$; **significant at $p < .01$

5.2.3. Construct validity

Construct validity asks whether the task on an instrument match generally accepted characteristics of the construct being measured. In determining construct validity, test developer examines scores on instruments attempting to measure the same variable as well as scores on measures of different but related variables (Starko, 2004). In this case, according to the Split Brain Theory derived from the split brain experiment evidences (Sperry, 1975), critical reasoning abilities are functions of the left brain. On the other hand, creative thinking abilities are the functions of the right brain. The instruments are: (1) The Watson-Glaser Critical Thinking Appraisal or WGCTA (Watson & Glaser, 1980). The WGCTA test is one of the most prominent critical thinking tests (Fulton, 1989). It was used to measure critical thinking skills of the subjects. It consisted of 80 items. The items are scored for five components of critical thinking based on the Watson and Glaser' critical thinking definition. The five components of critical thinking are (1) inference, (2) recognition of assumptions, (3) deduction, (4) interpretation, and (5) evaluation of arguments. (2) The Torrance Test of Creative Thinking or TTCT test, figural form (Torrance, 1984). The TTCT test is the most well known creative thinking test. It has been translated and used in more than 25 different languages (Khatena, 1982: 244). It was used to measure creative thinking skills of the subjects. It consisted of 3 sub-tests: Picture Construction, Picture Completion and Lines Activity. These sub-tests are scored for five components of creative thinking based on Torrance's definition of creative thinking. The five components are (1) fluency, (2) originality, (3) elaboration, (4) abstractness of titles, and (5) resistance to premature closure.

The subjects were 292 form four students (135 males, 157 females; age: 16.0 years old) from the Seri Serdang Secondary School. It was hypothesised that if the instruments reliably measure similar thinking element, one would expects positive relationship, despite the different contents and responses required.

The results of the Pearson correlations in Table 2 clearly indicate certain trends. It indicates that the YBRAINS scores of left brain style were positively and significantly correlated with the WGCTA critical thinking index ($r = .61$, $p < .05$) and its four components (inference: $r = .68$, $p < .05$; deduction: $r = .71$, $p < .01$; interpretation: $r = .55$, $p < .05$; and evaluation of arguments: $r = .63$, $p < .05$). On the other hand, the YBRAINS scores of right brain style were positively and significantly correlated with the TTCT creative thinking index ($r = .59$, $p < .05$) and its four components (fluency: $r = .55$, $p < .05$; originality: $r = .76$, $p < .05$; elaboration: $r = .63$, $p < .05$; and resistance to premature closure: $r = .44$, $p < .05$).

Table 2. Correlations between the scores of the YBRAINS with the scores of the TTCT and the WGCTA tests

Correlation	YBRAINS
WATSON-GLASER CRITICAL THINKING APPRAISAL (WGCTA)	Left Brain Style
Inference	.68*
Recognition of Assumptions	.27
Deduction	.71**
Interpretation	.55*
Evaluation of Arguments	.63*
Critical Thinking Index	.61*
TORRANCE TEST OF CREATIVE THINKING (TTCT)	Right Brain Style
Fluency	.55*
Originality	.76*
Elaboration	.63*
Abstractness of Titles	.21
Resistance to Premature Closure	.44*
Creative Thinking Index	.59*

Note: *significant at p< .05; **significant at p< .01

However, the relative low and insignificant correlation between the Recognition of Assumptions score of the WGCTA and the left brain style score of the YBRAINS (r= .27, p> .05) suggests that the two tests measuring different aspects of critical thinking Similarly, the relative low correlation between the Abstractness of Titles score of the TTCT and the right brain style score of the YBRAINS (r= .21, p> .05) suggests that the two tests assess different components of creative thinking via different test contents and from different perspectives. (YBRAINS measures thinking and learning styles while TTCT and WGCTA measure thinking skills).

The results suggest that the left brain style and right brain style of the YBRAINS reliably measure certain similar critical and creative thinking, as measured by the WGCTA and the TTCT tests, and these results are inline with the evidences of the split brain theory, that creative thinking is one of the functions of the right brain while critical thinking is one of the functions of the left brain.

5.2.4. Predictive validity

Predictive validity examines whether scores on a measure predicts its traits or performance at a later time. It asks not how a measure correlates with other measures today but how they may relate to activities tomorrow (Starko, 2004). Based on the split brain theory (Springer & Deutsch, 1993), it seemed reasonable to predict that arts major and music major subjects will score higher on the right brain style of the YBRAINS test. On the contrary, mathematics major and science major subjects will score higher on the left brain style. Table 3 depicts the results of a predictive study. The subjects of the study were 52 mathematics major, 45 music major, 48 science major and 49 fine arts major student teachers (final year undergraduates; 81 males, 113 females; average age: 22.3 years old) from the Kuala Lumpur Specialist Teacher Training Institute.

The data in Table 3 indicate that the music major and fine arts major students scored higher on the right brain style (music major: left brain style, M=14.21; right brain style, M=19.10; fine arts major: left brain style, M =14.33; right brain style, M=20.64). On the other hand, the mathematics major and science major subjects scored higher on the left brain style (mathematics major: left brain style, M =18.74; right brain style, M=15.45; science major: left brain style, M =19.50; right brain style, M=14.11). The results show the ability of the scores of the YBRAINS test in predicting the thinking and learning styles. Moreover, referring to the YBRAINS typography diagram (Figure 1), mathematics major and science major students demonstrated left brain style (YBARINS score: mathematics major = 3.61; science major score=4.11), while on the other hand, the music and fine arts students demonstrated right brain style (YBARINS score: music major = 6.31 ; fine arts =6.76).

Table 3: Mean and standard deviation scores of the four academic majors on the YBRAINS test

YBRAINS	Mathematics Major (n=52)		Music Major (n=45)		Science Major (n=48)		Fine Arts Major (n=49)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD

Left Brain Style	18.74	3.15	14.21	3.86	19.50	3.18	14.33	4.10
Right Brain Style	15.45	4.37	19.10	4.12	14.11	3.25	20.64	3.74
YBRAINS Score	3.61	0.93	6.31	0.89	4.11	0.81	6.76	0.69

In another study, Ling (2010) reviewed literature and found that Malaysian secondary school principals are working in a highly structured, systematic, rational, convergent thinking environment, and they are predicted as critical in thinking. Hence she hypothesised that the Malaysian school principals possess a left brain style. Her study on a group of school principals (n=85, aged 39 - 54) showed that 50.59% (n=43) of the respondents are left brain style thinkers, 48.24% (n=41) are whole brain style thinkers, and only one respondent possesses a right brain style (Table 4).

The three predictive validity studies' results show that to some extent, the YBRAINS test is able to predict the brain style of its respondent.

6. Conclusion

The reliability and validity studies that have been presented above indicate the ability of the YBRAINS scores to represent the brain styles of its respondents. The instrument could be used as an alternative measure to other thinking and learning style tests to understand human behaviours from a slightly different perspective. Since human thinking is a universal behaviour, the usage of the test might not limited only to the Malaysian secondary school students, however, reliability studies should be carried out before it could be widely used.

Table 4: Frequency and percentage of brain styles of a group of secondary school principals (n=85)

YBRAINS	N	%
Brain style		
Left Brain Style	43	50.59
Whole brain style	41	48.24
Right Brain Style	1	1.18
Thinking style		
Open style	69	81.18
Mixed style	12	14.12
Closed style	4	4.70

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